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Comorbidity Burden and Guideline-Concordant Care for Breast Cancer

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Abstract

OBJECTIVES—To explore the relationship between level and type of comorbidity and guideline-concordant care for early-stage breast cancer.

DESIGN—Cross-sectional.

SETTING—National Program of Cancer Registry (NPCR) Breast and Prostate Cancer Patterns of Care study, which re-abstracted medical records from 2004 in seven cancer registries.

PARTICIPANTS—Individuals with stage 0–III breast cancer.

MEASUREMENTS—Multicomponent guideline-concordant management was modeled based on tumor size, node status, and hormone receptor status, according to consensus guidelines. Comorbid conditions and severity were measured using the Adult Comorbidity Evaluation Index (ACE-27). Multivariate logistic regression models determined factors associated with guideline-concordant care and included overall ACE-27 scores and 26 separate ACE comorbidity categories, age, race, stage, and source of payment.

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RESULTS—The study sample included 6,439 women (mean age 58.7, range 20–99; 76% white; 44% with no comorbidity; 70% estrogen- or progesterone-receptor positive, or both; 31% human epidermal growth factor receptor 2 positive). Care was guideline concordant in 60%. Guideline concordance varied according to overall comorbidity burden (70% for none; 61% for minor; 58% for moderate, 43% for severe; $P < .05$). In multivariate analysis, the presence of hypertension (odds ratio (OR) = 1.15, 95% confidence interval (CI) = 1.01–1.30) predicted guideline concordance, whereas dementia (OR = 0.45, 95% CI = 0.24–0.82) predicted lack of guideline concordance. Older age (≥50) and black race were associated with less guideline concordance, regardless of comorbidity level.

CONCLUSION—When reporting survival outcomes in individuals with breast cancer with comorbidity, adherence to care guidelines should be among the covariates.

Keywords

breast cancer; comorbidity; guideline concordance

In individuals with breast cancer, comorbidity is linked to lower overall and disease-specific survival.[1,2] This association may be through effects on disease biology, receipt of or response to treatment, or to other factors. Treatment of breast cancer requires multicomponent care, including surgery, radiation therapy (RT), endocrine therapy (ET), and chemotherapy (CTX). With adjuvant CTX,[3,4] toxicity is a concern.[5] Adjuvant RT after breast-conserving surgery (BCS) is less often used in the presence of comorbidity.[6] Certain comorbidities may also have different effects on survival, disease course, and treatment.[1,7] Prior studies examining the relationship between guideline care and comorbidity did not study dose-response or specific comorbidities.[1,3,8,9] The use of the Adult Comorbidity Evaluation Index (ACE-27), which includes 26 comorbidities and disease severity, adds breadth and power to the analysis.[10]

Decades of clinical research led to multidisciplinary guidelines that minimize recurrence and extend survival in women with breast cancer,[11,12] but guidelines do not account for comorbidity, and the relationship between guideline concordance and comorbidity is understudied. The authors of the current study are aware of only one report of multidisciplinary care, which used the Charlson Comorbidity Index derived from administrative data.[13] Furthermore, it is important to try to disentangle the independent effects of age and comorbidity and not just assume that it is morbidity burden in elderly adults that effects concordance. This study aimed to examine the relationship between comorbidity, with attention to overall burden and specific comorbid conditions, and receipt of multicomponent guideline-concordant care. It was hypothesized that age and comorbidity burden would have independent effects on guideline concordance.

METHODS

Data Source

The National Program of Cancer Registry (NPCR) Breast and Prostate Cancer Data Quality and Patterns of Care Study (POC-BP) study[14,15] included individuals with breast cancer diagnosed in 2004 from seven population-based cancer registries (California, Georgia,

Kentucky, Louisiana, Minnesota, North Carolina, Wisconsin). Human subjects committee approval was obtained from each participating institution. Re-abstraction of hospital and physician office records supplemented registry data on initial course of treatment. Additional data on adjuvant therapy and comorbidities were obtained from physicians and outpatient facilities. Cases were randomly selected across strata of race and ethnicity and state-specific factors (e.g., Appalachian vs non-Appalachian region, type of facility, and patient volume of the facility) and oversampled for racial and ethnic minorities in some states. Cases from Veterans Affairs hospitals and identified solely from death certificates or autopsies were excluded.

Study Sample

The initial sample included 9,142 women with breast cancer. Exclusion criteria were missing stage (n = 1,601); metastatic cancer (n = 358); missing tumor size, if nodal status negative or hormone receptor status missing (n = 94); missing nodal status (n = 185); no primary breast tumor (T0, n = 22); and missing hormone receptor status and did not receive ET (n = 418). Cases in which RT (n = 105), ET (n = 257), and CTX (n = 218) and breast (n = 15) or node (n = 14) surgeries were unknown were also excluded. This excluded 2,703 women, leaving a final sample of 6,439. Characteristics of included women were different from those excluded with regard to payor (more Medicare, less Medicaid), race (more blacks, fewer Hispanics) and stage (more Stage 0, fewer Stage 2 and 3).

Hormone receptor (estrogen (ER) and progesterone (PR) status was defined as positive (ER+ or PR+, or both), negative (ER− and PR−), or unknown. Human epidermal growth factor receptor 2 (HER2) status was defined as positive (3 + according to immunohistochemistry (IHC) or amplified using fluorescent in situ hybridization (FISH)), negative (0 or 1 + according to IHC or 2 + according to IHC and not amplified using FISH), or unknown, although HER2 status was not consistently recorded for early-stage breast cancer cases in 2004.

Outcomes

The primary outcome was receipt of guideline-concordant care or not. Guideline-concordant breast cancer treatment was defined based on tumor size, nodal status, and hormone receptor status, similar to previous work.[13] For each of 10 categories, National Comprehensive Cancer Network[16] and St. Gallen Conference[17] guidelines were consulted to create management requirements, which included components of surgery (BCS or mastectomy), adjuvant RT (before, during, or after surgery), lymph node surgery (LN), CTX, and ET. Minimum acceptable components of therapy for each group are as follows:

Group A (ductal carcinoma in situ (DCIS)), BCS with RT or mastectomy

Group B (T1a-b N0), BCS with RT and LN or mastectomy and LN

Group C+ (T1cN0, >1 cm, ER with PR+), BCS with RT or mastectomy, LN, ET, and CTX if younger than 70

Group C− (T1c N0, ER with PR−), BCS with RT or mastectomy, LN, and CTX

Group D+ (T2N0, ER with PR+), BCS with RT or mastectomy, LN, ET, and CTX

Group D− (T2N0, ER with PR−), BCS with RT or mastectomy, LN, and CTX

Group E+ (T1–3 N1–3 or T3N0, and ER with PR+), BCS with RT or mastectomy, LN, ET, and CTX

Group E− (T1–3N1–3 or T3N0 and ER with PR−), BCS with RT or mastectomy, LN, and CTX

Group F+ (T4NX and ER with PR+), mastectomy, LN, ET, and CXT

Group F− (T4NX and ER with PR−), mastectomy, LN, and CTX

Receipt of more than guideline management was considered guideline concordant.

Comorbidity

The ACE-27,[10] a robust, validated, chart-based instrument developed specifically for individuals with cancer, was used. The index includes 26 conditions relevant to cancer therapy choice and outcome, and their severity, measured according to three levels of decompensation. After training using a tested and validated Internet-based program, abstractors reviewed records and assigned comorbidity categories and level of decompensation based on diagnoses, medical history, and laboratory and clinical tests.[10,18] Comorbidities present at or before diagnosis were included; complications of treatment were excluded. An overall comorbidity index (none, low, moderate, or severe) was assigned to each participant based on the comorbidity with the highest level of decompensation. Severe level of decompensation for the overall index was assigned in cases in which there was a moderate level of decompensation of two or more comorbidities in different body systems (e.g., cardiovascular and nervous), even if none were severe.[18]

The 26 categories were also mapped into 12 groups, based on organ system: cardiovascular disease (myocardial infarction, coronary artery disease, congestive heart failure, arrhythmia, hypertension, venous disease, peripheral artery disease), respiratory diseases, gastrointestinal diseases (hepatic disease, stomach or intestinal diseases, pancreatic disease), renal disease, diabetes mellitus, nervous system (stroke or cerebrovascular accident, dementia, paralysis, neuromuscular disorders), psychiatric, rheumatological, acquired immunodeficiency syndrome (AIDS), cancer (solid tumor, leukemia, lymphoma) excluding the index cancer, substance abuse (alcohol abuse, illicit drugs), morbid obesity.

Statistical Analysis

Cases were stratified according to overall comorbidity burden (none, minor, moderate, severe). Receipt of guideline-concordant breast cancer care, for each group across the aggregated and disaggregated measures of burden, was compared using chi-square statistics. Similar analyses were conducted for each of the 12 mapped comorbidity categories (as above). Finally, multivariate logistic regressions were estimated using three comorbidity classifications: 26 ACE-27 comorbidity categories (Model 1), 12 collapsed ACE-27 categories (Model 2), and four levels of comorbidity (Model 3). Three models were created to maximally explore specific comorbidities and groups of comorbidities and to study the dose-response relationship overall. With these regressions, the statistics are reported for four age categories (<50, 50–64, 65–74, ≥75) and four racial ethnic groups (white, black,

Hispanic, other), because these are factors known to be related to comorbidity and to guideline concordance and control for the 10 stage groups and source of payment. SAS version 9.2 was used throughout the analyses (SAS Institute, Inc., Cary, NC).

RESULTS

The study population was primarily Caucasian (76.0%), with mean age of 58.7 (range 20–99; Table 1). ACE comorbidity level was severe in 3.9%, moderate in 9.9%, mild in 42.0%, and none in 44.3%. The most common comorbidities were cardiovascular disease (n = 2,952, 45.8%), diabetes mellitus (n = 802, 12.5%), morbid obesity (n = 534, 8.3%), psychiatric disease (n = 381, 5.9%), and respiratory disease (n = 380, 5.9%).

Care was guideline concordant in two-thirds of participants (69.5% without comorbidity, 59.5% with). Surgery was BCS in 57.9% and mastectomy in 40.9%; 82.7% had had a LN assessment. RT occurred in 80.6% of participants who underwent BCS. CTX was delivered to 38.9%. ET was used in 54.7% overall and in 71% of women with ER+ or PR+ tumors or both.

Table 2 shows the unadjusted rate of guideline-concordant care according to stage and comorbidity categories. Guideline concordance varied between stage groups (unreported chi-square $P < .001$), and level of comorbidity ($P < .05$). Concordance was inversely proportional to comorbidity burden: 69.5% for none, 61.4% for minor, 58.0% for moderate, and 42.7% for severe, although this inverse relationship is statistically significant for only some individual stage groups (e.g., individuals with DCIS (A)). Table 2 also shows statistically significant relationships between individual comorbidity categories and guideline-concordant treatment for a number of conditions, including cardiovascular disease, end-stage renal disease, diabetes mellitus, nervous system disorders, psychiatric disorders, and rheumatological disease. For all but psychiatric disorders, the presence of the condition was always associated with less-concordant care. In some cases, such as diabetes mellitus and nervous system disorders, there is a clear inverse relationship between severity and concordance.

Any comorbidity, versus none, was associated with less-guideline-concordant care ($P < .05$) in four stage strata (stage I, tumor >1 cm and hormone receptor positive (C+), 26.1% vs 37.7%; stage IIA and hormone receptor positive (D+), 29.5% vs 53.2%; stage IIA and hormone receptor negative (D−), 53.1% vs 75%; and stage IIB or III and hormone receptor positive (E+), 56.8% vs 67.5%) and overall (59.5% vs 69.5%). The presence of comorbidity did not significantly affect the rate of guideline-concordant care for DCIS or less than 1 cm, node-negative cancers, for which only local therapy met guideline concordance. Few cases of higher-stage cancer may have limited the ability to find significant differences in rates of guideline-concordant care according to comorbidity level.

The effect of specific diagnosis and severity on receipt of guideline-concordant care was examined (Table 2). In unadjusted analyses, comparing any comorbidity with none, receipt of guideline-concordant care was less likely ($P < .05$) with cardiovascular diseases (58% vs 69%), renal disease (37% vs 64%), diabetes mellitus (54% vs 65%), nervous system disease

(35% vs 65%), and rheumatological disease (49% vs 64%). Delivery of guideline-concordant care was more likely (univariate $P < .05$) with psychiatric illness (70% vs 63%). In univariate analysis, with comorbidity categorized according to level of severity, significant differences in guideline-concordant care ($P < .05$) were found for diabetes mellitus and for cardiovascular, renal, and nervous system diseases. For AIDS, other cancers, substance abuse, and obesity, small numbers limited detection of a dose-response relationship.

Table 3 shows results of multivariate analyses using three models. In Model 1, less guideline concordance was associated with dementia (OR = 0.45, 95% CI = 0.24–0.83), older age, and black race (vs white OR = 0.87, 95% CI = 0.76–0.99) and higher likelihood of guideline concordance with hypertension (OR = 1.15, 95% CI = 1.01–1.30). In Model 2, less guideline concordance was associated with renal system disease (OR = 0.57, 95% CI = 0.33–0.99), nervous system disease (OR = 0.62, 95% CI = 0.47–0.82), and older age. In Model 3, less guideline concordance was associated with severe comorbidity (OR = 0.67, 95% CI = 0.51–0.89), older age, and black race.

DISCUSSION

Using this large, retrospective database, with systematically collected, detailed information about comorbid diagnoses and tumor registry and record-based information about multicomponent breast cancer management, the authors of this study confirmed that higher comorbidity is associated with a lower rate of multidisciplinary guideline-concordant care. Older age and black race also predicted less guideline concordance.[19,20] This adds to the literature by exploring the effect of specific comorbid diagnoses on receipt of guideline-concordant breast cancer care. In unadjusted analyses, guideline concordance was lower with cardiovascular, renal, nervous system, and rheumatological diseases and diabetes mellitus; this held true in adjusted analyses for renal and nervous system diseases. With regard to specific diagnoses, dementia was associated with less-guideline-concordant care whereas hypertension was associated with small, but statistically significantly greater guideline concordance.

It may be that a diagnosis of hypertension implies more access to health care and, therefore, greater likelihood of guideline concordance and better outcomes. Individuals with a diagnosis of hypertension are likely to receive antihypertensive medication and are more likely to receive guideline-concordant care, either of which might improve outcomes. Thus, use of guideline-concordant breast cancer care may have confounded previous reports that antihypertensive use improves breast cancer prognosis.[7,21–23] Future research studying the effects of comorbid diagnoses and their treatment on breast cancer outcome should include an assessment of guideline-concordant cancer treatment.

In general, higher comorbidity burden led to less guideline-concordant care, which may be justified, given the known inverse relationship between comorbidity and life expectancy[24] and higher financial or quality-of-life burdens, especially in those with high comorbidity burden. Comorbidity may decrease the benefits or increase the risk of certain components of care. For instance, the current study found that individuals with stage IIA disease (T2N0),

regardless of hormone receptor status, and stage IIB and III disease with hormone receptor–positive disease, in which the absolute benefit of adding chemotherapy is small, were significantly less likely to receive guideline-concordant care.

Strengths of this study include the large, geographically diverse database, with tumor registry data augmented with chart abstraction, and use of the ACE-27 comorbidity measure. Record re-abstraction enabled capture of detailed information about tumor characteristics, treatment, and comorbid conditions. Whereas most studies of comorbidity were limited to older adults with Medicare, this study included individuals aged 20–99. Large sample size and availability of well-defined variables pertaining to demographic, participant, tumor, and treatment characteristics facilitated study of multicomponent management. Whereas other studies have primarily focused on single treatment components, the rich database allowed study of multicomponent, coordinated care. Use of the ACE-27, a robust, validated, chart-based instrument, developed specifically for individuals with cancer to study presence and severity of comorbidity, is a tremendous strength of the study.[10] Other studies have used less-powerful measures of comorbidity.[1,3,8,9] The widely used Charlson Comorbidity Index[25,26] can be used with administrative databases but includes fewer comorbidities and no information about disease severity. The Cumulative Illness Rating Scale, perhaps the most-comprehensive index, requires detail only available in prospective studies.[27] A claims-based version of the ACE has been proposed.[28] Detailed information from the ACE-27 also allowed associations with specific comorbid diagnoses, rather than only a summary score of comorbidity, to be explored.[5]

There are limitations to this study. As a retrospective study, what was recorded in the medical record, which is a poor source of information about physician and individual decision-making, actual referrals, and patient adherence, limited it. Lack of record review from each involved physician may have led to missed care components, but the abstractors sought records from hospital and physician offices. Inclusion criteria for the analysis excluded approximately 25% of the database and may limit external validity of the findings. Small numbers in some subcategories limited power. Last, the study was structured to detect treatment meeting minimum standards; because less than guideline care is known to be associated with worse outcomes, it was felt that overclassification in this direction was acceptable.

In summary, this study found that greater comorbidity burden is associated with a lower rate of guideline-concordant multidisciplinary care. The noted association between guideline care and hypertension is worthy of further study. Because less than guideline-concordant care for breast cancer, regardless of age or race, leads to inferior outcomes,[29,30] where possible in studies of cancer outcome, guideline concordance should be included in analyses.

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Conflict of Interest: Dr. Kimmick has served on speakers boards; been a consultant for AstraZeneca, Pfizer, and Novartis; and has received research funding from Astra-Zeneca, Pfizer, Roche, Bionovo, Wyeth, Bristol-Myers Squibb, and GlaxoSmithKline. Dr. Anderson has had research funding from AstraZeneca and Roche. None of the other authors have financial interests, activities, relationships, or affiliations that would pose a conflict of interest with the content of this manuscript.

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Table 1

Characteristics of the Sample (N = 6,439)

Characteristic	N	Weighted Percentage
Age		
<50	1,830	26.7
50–64	2,419	37.7
≥65	2,190	35.6
Race or ethnicity		
White	3,643	76.0
Black	1,910	15.3
Hispanic	488	5.2
Other	396	3.5
Source of payment		
Medicare plus other public insurance	1,432	23.1
Medicaid	835	9.1
Private	3,765	61.6
Not insured or self-pay	177	1.8
Unknown	230	4.4
Adult Comorbidity Evaluation score[a]		
None	2,784	44.3
Mild	2,729	42.0
Moderate	654	9.9
Severe	272	3.9
Stage		
0	1,290	19.9
I	2,873	47.1
II	1,773	26.3
III	503	6.7
Hormone receptor status		
Positive (ER+ or PR+)	4,398	70.0
Negative (ER− and PR−)	1,470	21.4
Unknown	571	8.6
HER2 status		
Positive	1,962	30.5
Negative	2,713	42.1
Unknown	1,764	27.4
Type of surgery		
BCS	3,645	57.9
Mastectomy	2,701	40.9

Characteristic	N	Weighted Percentage
None	93	1.2
Lymph node assessment	5,293	82.7
Radiation after BCS	2,967	80.6[b]
Adjuvant chemotherapy		
Single agents	73	1.1
Doxorubicin and cyclophosphamide	704	9.9
Doxorubicin, cyclophosphamide, and a taxane	1,236	18.6
Other multiple agents	663	9.4
None	3,765	61.1
Endocrine therapy	3,428	54.7
Trastuzumab[c]	169	2.9

[a]Diseases included myocardial infarction, angina pectoris or coronary artery disease, congestive heart failure, arrhythmias, hypertension, venous disease, peripheral arterial disease, respiratory system disease, hepatic disease, stomach or intestinal disease, pancreatic disease, end-stage renal disease, diabetes mellitus, stroke, dementia, paralysis, neuromuscular disease, psychiatric disorder, rheumatologic disease, acquired immunodeficiency syndrome, solid tumor including melanoma, leukemia or myeloma, lymphoma, alcohol abuse, illicit drugs, obesity.

[b]Percent who received adjuvant RT among those who had BCS.

[c]Trastuzumab was delivered to 2.9% overall and 8.1% of human epidermal growth factor receptor 2 (HER2)-positive cancers.

ER = Estrogen Receptor; PR = Progesterone Receptor; BCS = Breast-Conserving Surgery.

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Table 2

Percentage Guideline Concordance According to Stage Group, Comorbidity (Collapsed Adult Comorbidity Evaluation (ACE-27) Comorbidity Categories), and Comorbidity Level in Individuals with Breast Cancer (N = 6,439)

	None	Minor	Moderate	Severe	Any Comorbidity
	n (% Yes)				
Comorbidity level					
A (ductal carcinoma in situ)[a]	**554 (81.8)**	**577 (80.4)**	**101 (74.0)**	**42 (46.2)**	**720 (77.7)**
B (T1a/b N0)	449 (88.2)	480 (84.9)	114 (82.5)	43 (83.2)	637 (84.4)
C+ (T1c N0, ER/PR+)[a,b]	**447 (37.7)**	**447 (26.7)**	**110 (27.6)**	**47 (15.3)**	**604 (26.1)**
C− (T1c N0, ER/PR−)[a]	**127 (72.3)**	**125 (56.5)**	**24 (85.7)**	**11 (19.6)**	**160 (58.6)**
D+ (T2N0, ER/PR+)[a,b]	**208 (53.2)**	**224 (34.4)**	**57 (18.8)**	**27 (12.2)**	**308 (29.5)**
D− (T2N0, ER/PR−)[a,b]	**139 (75.0)**	**119 (51.6)**	**26 (70.0)**	**10 (27.5)**	**155 (53.1)**
E+ (T1–3N1–3 or T3N0, ER/PR+)[a,b]	**581 (67.5)**	**502 (57.6)**	**136 (57.7)**	**47 (43.7)**	**685 (56.8)**
E− (T1–1N1–3 or T3N0, ER/PR−)	209 (84.9)	182 (83.9)	56 (80.7)	30 (62.1)	268 (80.0)
F+ (T4NX, ER/PR+)	37 (57.2)	37 (48.6)	21 (60.9)	9 (40.0)	67 (51.6)
F− (T4NX, ER/PR+)	33 (52.2)	36 (75.6)	9 (77.3)	6 (48.5)	51 (71.3)
All[a,b]	**2,784 (69.5)**	**2,729 (61.4)**	**654 (58.0)**	**272 (42.7)**	**3,655 (59.5)**
Morbidity					All Levels
Cardiovascular disease[c,d,e]	**3,487 (68.8)**	**2,559 (59.9)**	**324 (43.6)**	**69 (47.9)**	**2,952 (57.6)**
Respiratory disease	6,059 (64.1)	339 (61.3)	23 (63.3)	18 (44.9)	380 (60.7)
Gastrointestinal disease[f]	6,268 (64.1)	153 (52.2)	16 (77.1)	2 (100.0)	171 (55.0)
End-stage renal disease[c,d]	**6,378 (64.1)**	**42 (38.9)**	**13 (12.1)**	**6 (62.7)**	**61 (37.4)**
Diabetes mellitus[c,d]	**5,637 (65.1)**	**669 (55.3)**	**99 (46.9)**	**34 (40.7)**	**802 (53.7)**
Nervous system disease[c,d,g]	**6,170 (65.3)**	**196 (37.1)**	**52 (33.4)**	**21 (15.0)**	**269 (34.8)**
Psychiatric disease[c,d]	**6,058 (63.4)**	**354 (71.0)**	**24 (35.4)**	**3 (89.5)**	**381 (70.0)**
Rheumatological disease[,d]	**6,305 (64.2)**	**104 (50.3)**	**28 (46.5)**	**2 (0.0)**	**134 (49.0)**
Acquired immunodeficiency syndrome	6,434 (63.9)	5 (41.8)	0 (0.0)	0 (0.0)	5 (41.8)

	None	Minor	Moderate	Severe	Any Comorbidity
			n (% Yes)		
Cancer[h]	6,395 (63.9)	25 (59.3)	3 (12.4)	16 (51.5)	44 (52.3)
Substance abuse[i]	6,386 (63.8)	35 (71.7)	14 (82.0)	4 (0.0)	53 (71.0)
Obesity	5,905 (63.8)	203 (57.5)	318 (69.1)	13 (68.3)	534 (64.5)

For comorbidity categories, weighted percentage with guideline-concordant care was used.

[a] Statistically significant comparing four levels of comorbidity, chi-square, $P < .05$.

[b] Statistically significant comparing any comorbidity versus none, chi-square, $P < .05$. (for group C−, all levels, $P = .05$).

[c] Statistically significant three levels of comorbidity and none, chi-square, $P < .05$.

[d] Statistically significant all levels of comorbidity versus none, chi-square, $P < .05$.

[e] Myocardial infarction, coronary artery disease, congestive heart failure, arrhythmia, hypertension, venous disease, and peripheral artery disease.

[f] Hepatic disease, stomach and intestinal diseases, and pancreatic disease.

[g] Stroke or cerebrovascular accident, dementia, paralysis, and neuromuscular disorders.

[h] Solid tumor, leukemia, or lymphoma.

[i] Alcohol abuse and illicit drugs.

ER = Estrogen Receptor; PR = Progesterone Receptor.

Table 3

Multivariate Logistic Regression[a] of Guideline-Concordant Care According to Comorbidity, Age, and Race in Individuals with Breast Cancer (N = 6,208[b])

Comorbidity Group (Model)		Model 1 (Includes Each 26 Separate ACE-27 Comorbidity Categories in the Model)	Model 2 (Includes 12 Collapsed ACE-27 Categories in the Model)	Model 3 (Includes 4 Levels of Comorbidity in the Model)
1 (1)	2 (2)	Odds Ratio (95% Confidence Interval)		
Myocardial infarction		0.94 (0.64–1.37)		
Coronary artery disease		0.97 (0.74–1.28)		
Congestive heart failure		0.74 (0.52–1.07)		
Arrhythmia		0.90 (0.64–1.26)		
Hypertension		**1.15 (1.01–1.30)[c]**		
Venous disease		1.13 (0.67–1.92)		
Peripheral arterial disease	Cardiovascular	0.67 (0.36–1.22)	1.13 (1.00–1.28)	
Respiratory disease	Respiratory	1.18 (0.93–1.51)	1.14 (0.89–1.44)	
Hepatic disease		0.62 (0.33–1.19)		
Stomach or intestinal disease		1.01 (0.68–1.51)		
Pancreatic disease	Gastrointestinal		0.88 (0.63–1.23)	
Renal system disease	Renal system disease	0.64 (0.36–1.12)	**0.57 (0.33–0.99)[c]**	
Diabetes mellitus	Diabetes mellitus	0.91 (0.76–1.08)	0.88 (0.75–1.06)	
Stroke or cerebrovascular accident		0.78 (0.55–1.11)		
Dementia		**0.45 (0.24–0.83)[c]**		
Paralysis		0.88 (0.14–5.66)		
Neuromuscular disease	Nervous system	0.62 (0.34–1.15)	**0.62 (0.47–0.82)[c]**	
Psychiatric disease	Psychiatric disease	1.28 (1.00–1.63)	1.27 (0.99–1.62)	
Rheumatological disease	Rheumatological disease	0.79 (0.54–1.15)	0.80 (0.55–1.17)	
AIDS	AIDS	0.25 (0.04–1.52)	0.25 (0.04–1.53)	
Solid tumor		0.54 (0.27–1.09)		
Leukemia				
Lymphoma	Cancer		0.623 (0.328–1.183)	

Comorbidity Group (Model)		Model 1 (Includes Each 26 Separate ACE-27 Comorbidity Categories in the Model)	Model 2 (Includes 12 Collapsed ACE-27 Categories in the Model)	Model 3 (Includes 4 Levels of Comorbidity in the Model)
1 (1)	2 (2)	Odds Ratio (95% Confidence Interval)		
Alcohol abuse		1.006 (0.487–2.077)		
Illicit drugs	Substance abuse	0.827 (0.296–2.310)	1.021 (0.547–1.904)	
Obesity	Obesity	1.108 (0.900–1.363)	1.108 (0.901–1.363)	
Comorbidity index (vs none)				
Mild				1.124 (0.990–1.277)
Moderate				1.117 (0.919–1.359)
Severe				**0.673 (0.507–0.893)**[c]
Age (vs <50)				
50–64		**0.653 (0.563–0.757)**[c]	**0.657 (0.566–0.762)**[c]	**0.652 (0.563–0.756)**[c]
65–74		**0.394 (0.325–0.478)**[c]	**0.395 (0.326–0.480)**[‡]	**0.385 (0.318–0.465)**[c]
≥75		**0.135 (0.109–0.167)**[c]	**0.131 (0.106–0.162)**[c]	**0.126 (0.102–0.155)**[c]
Race (vs white)				
Black		**0.872 (0.763–0.996)**[c]	0.878 (0.769–1.002)	**0.873 (0.767–0.993)**[c]
Hispanic		0.924 (0.743–1.149)	0.932 (0.749–1.159)	0.907 (0.730–1.126)
Other		0.944 (0.741–1.203)	0.949 (0.745–1.208)	0.933 (0.733–1.186)

[a] Controlling for stage and source of payment; pancreatic disease, lymphoma, and leukemia excluded from Model 1 because of too few observations (<5).

[b] Observations excluded (n = 231) for missing payer or race, also omitted metastatic, missing stage, if both PR and ER receptors missing, and if tumor size missing and nodes less than N1.

[c] Statistically significant, three levels of comorbidity and none, chi-square, $P < .05$.

ACE = Adult Comorbidity Evaluation; AIDS = acquired immunodeficiency syndrome.